TRAINING TO IMPROVE SITUATIONAL AWARENESS

Katharine Golas, Ph.D.
Bruce Montag
Southwest Research Institue
San Antonio, Texas

Captain Peter D. Hottenstein, Jr.
US Air Force
Tyndall AFB, FL 32403

ABSTRACT

The Air Force is currently implementing 3D modeling and simulation technologies on a new training system for Airborne Warning and Control Systems (AWACS) Weapons Directors (WDs). When students are learning to become AWACS WDs, they must attain the knowledge and develop the judgment and decision-making abilities required to direct fighters in combat. The most critical skill they learn is how to maintain situational awareness of the 4D air environment. The WD must learn to recognize which tactics are being employed during an engagement and be able to anticipate a pilot's needs and serve them. While they are communicating, both pilot and WD need to have the same conceptual understanding of what is taking place in the air situation. Until now, AWACS WDs gained this knowledge solely through mission experience.

Aircraft track data appears on the AWACS console as 2D symbology. To ensure that AWACS WD students are forming the appropriate mental models concerning the air situation and air order of battle, a new training simulator has been developed, called the AWACS Modeling and Simulation (AMS) Training System. This paper describes how the AMS training system improves the situational awareness of the Weapons Director through a combination of instructional strategies and training technologies aimed at producing students who are skilled job performers, that is, mission-ready.

ABOUT THE AUTHORS

Dr. Katharine C. Golas is manager of the Instructional Systems Section in the Training Systems and Simulators Department at Southwest Research Institute. During the past 19 years, she has directed over 80 Instructional Systems Development (ISD) projects. She is currently directing research and development efforts using 3D multimedia training technologies. She has PhD and MS degrees in Instructional Systems from Florida State University.

Bruce Montag is manager of the Advanced Simulation and Training Concepts Section in the Training Systems and Simulators Department at Southwest Research Institute. He has over 13 years of experience in simulation and modeling. He has led the development of several modeling and simulation efforts, including the Air Force tactics analysis and production system and the AWACS training system. He is currently managing technical development of several advanced image-generation programs.

Captain Pete Hottenstein has seven years of experience as a Weapons Director, senior director, instructor, and stan/eval officer on the E3 AWACS aircraft. He has served as the Chief of Command and Control Requirements for the 325th Training Squadron since 1992 and he currently serving as the Contracting Officer's Technical Representative (COTR) for the AWACS Modeling and Simulation training system. He has an MBA from Oklahoma City University.

TRAINING TO IMPROVE SITUATIONAL AWARENESS

Katharine Golas, Ph.D.
Bruce Montag
Southwest Research Institue
San Antonio, Texas

Captain Peter D. Hottenstein, Jr.
US Air Force
Tyndall AFB, FL 32403

INTRODUCTION

Since the initial implementation of radar early warning systems in England in the mid-1930s, there has existed a challenge of how to train radar operators, such as air traffic controllers, to interpret the radar display and describe what they are seeing to the pilot. Though their radar display is two-dimensional, controllers must envision the plane's flight paths in three dimensions, then project the paths through time. For example, the controller must take into account that one plane is turning sharply and rapidly descending, while another is slowly climbing. Alarmed, the controller will quickly get on his radio to instruct one of the pilots to change course. Only if his message is not garbled, drowned out, or misunderstood may an accident be averted.

Current FAA radar systems require wide separation standards because controllers need large margins of error when making four-dimensional calculations in their heads. Airliners are usually required to stay on rigid flight paths because it is easier for controllers to keep track of them.

In the military, air traffic control takes on a new meaning when describing the job of the Weapons Director on a surveillance aircraft such as the E3 Airborne Warning and Control System (AWACS). The job of the Weapons Director is more complicated than that of the typical air traffic controller because the WD has the additional responsibility of enhancing the combat capability of the fighters he controls. Not only does he transmit data about the planes' location, direction, and speed, he also communicates command directives, mission updates/changes, weather updates, airfield closures, refueling information, and coordination between other fighting elements both airborne and on the ground.

In order for the Weapons Director to perform effectively, he must develop and maintain *situational awareness* of all aspects of the air engagement including the position and state of aircraft such as heading, altitude and speed. Situational awareness includes an understanding of the general military and political situation; the type of mission assigned to each specific aircraft; the objectives and target locations for each mission; the intentions of the pilots; the atmospheric conditions affecting their radar; and the capabilities of the aircraft radar and communications equipment.

Since much of this information is impossible to extract from a 2D radar scope display, the WD must use his only other source of information ó verbal communication with the pilot. The WD collects and processes different bits of information from various sources and then decides which information is appropriate to convey to the pilot and when it should be conveyed to enhance the pilot's ability to employ his aircraft. The WD often performs a variety of tasks simultaneously, including listening and talking to pilots and fellow controllers, watching the radar display, using the keyboard and trackball, receiving and discarding information, planning ahead, and organizing the resources required for control activities.

The AWACS Modeling and Simulation (AMS) training system provides a combination of simulation and live exercises, a display and debriefing system, embedded interactive courseware (ICW), and speech recognition to ensure that WD students build the appropriate mental models which will enable them to rapidly interpret all the sensory inputs and accurately present them to the pilot when needed.

DESCRIPTION OF SITUATIONAL AWARENESS IN A WEAPONS CONTROL ENVIRONMENT

Pilot's Perspective

Even though fighters may be performing what looks like a simple intercept mission, weapons employment drives all parts of their mission, including simple one-on-one intercept missions. Weapons employment is concerned with how the pilots are going to best employ their weapons while respecting the capabilities of the adversaries and their weapons. Every missile and every bomb is designed with particular features which optimize the weapon's capability. The bottom line during any mission is for the pilot to kill the adversary. To do this he must fly the jet, operate the radar, respond to multiple indicators which identify threats and aircraft malfunctions, and coordinate through various communications systems.

The pilot cannot afford to miss any one input, even when he is inundated by multiple inputs at any given moment. One of these inputs is the voice of a Weapons Director who is assigned to guide and direct him to the target. Because the WD is not always available, pilots are trained to operate with or without his help. For this reason, a WD's inputs are often placed at a low priority depending on the pilot's level of task saturation. With so many things vying for a pilot's attention, he is constantly setting and adjusting priorities. If the jet needs attention the pilot handles that. If the threat needs attention he handles that. Sometimes an immediate priority takes the pilot's attention away from a critical input, such as the input of the WD, that could end up saving his life. If a WD is talking on the radio at an inappropriate time, or is talking about things that are not relevant to the task at hand, it is difficult for the pilot to digest the information and he may ignore it in order to deal with the situation. WDs need to understand what is going on in the cockpit and the air environment in order to integrate their inputs into the flow of events.

If the pilot perceives that the WD is making errors during communications, he will be less inclined to pay attention to the WD's inputs. This is especially true under high stress conditions when the pilotís ability to process inputs is reduced. A pilotís perception of the WD's capabilities varies depending on his understanding of the limitations of the WD's equipment. If the pilot does not know what to expect from the WD he may end up expecting more than the WD can actually contribute. For example, the pilot may expect the WD to be able to provide altitude information about the adversary. Because of equipment limitations, the WD may not have information that is as accurate as the pilot's. When the WD tells the pilot an altitude that does not match what the pilot reads, the pilot will give less credibility to everything the WD has to say or he may ignore the WD entirely. The result is a less effective team due to a lack of trust between the members.

Weapons Director Perspective

Understanding the pilot's perspective and where the WD fits into the weapons employment process is critical to mission success or failure. Everything the WD does should be directed toward optimizing what the pilots are trying to accomplish. The WD must learn to recognize the weapons employment tactics that are being used, by both his pilots and the opponents during a particular engagement, and be able to anticipate his pilots' needs and serve them. The WD's job is to look at a 2D radar display, listen to communications between his pilots and, from that, recognize what is taking place. Additionally, the WD must know what information the pilot needs at each phase of the mission and provide it at exactly the appropriate time when the pilot expects the information.

Once a WD is in an operational setting there is very little opportunity for interaction with the pilots he will control, even though the WD is expected to be part of the team as the "other wingman." Most successful missions include "face to face" briefings and debriefings where every detail of the mission is reviewed to ensure full understanding by all team members of the mission objectives and the rules surrounding the mission. Since WDs are rarely located where they can participate in the "face to face" briefings, many nuances of the mission are left to the WD's interpretation based on past experience. If the WD is not thoroughly familiar with all the potential tactics the pilots may use, he will not be able to anticipate the points during the mission when he can have the greatest impact.

The quickest way for a WD to be completely ignored by a pilot is if he performs in a way that degrades the pilot's abilities to operate, or worse yet, results in the adversaries gaining the upper hand. There are many conditions that could cause the WD to misinterpret the situation and provide erroneous information to the pilot. The main problem the WD has is the radar display. The display resolution is less than adequate in some situations, which forces the WD to rely solely on the communications he hears from the pilots. All communications are done through a system of code words. If the WD misinterprets the code words he may not know what is taking place or may assume one course of action when the pilot is executing another. Many of the code word definitions are related to a specific flight maneuver or weapons employment tactic and are difficult to understand without a visual image of the action described by the code word. Only when the correct mental models are associated with the radar display and the code words, will the WD be able to anticipate the pilot's needs and provide accurate and timely inputs.

Problems Encountered by the Weapons Director

Hardware Limitations. Aircraft track data appears on the AWACS console as 2D symbology in a 2D display. To the untrained eye there is no indication that the scenario is playing out in a 3D environment. To make matters worse, the radar presentation and the radio communications are not always accurate or descriptive enough to portray with certainty what is actually taking place. The radar processor delays the image at varying rates, which may cause the WD to tell the pilot useless and distracting information about something that has already happened.

Task Saturation. During missions with high sortie activity and an extensive command and control structure, there are many demands placed on the WD in addition to controlling a flight of aircraft. During such a mission the WD is required to provide information to other crew members on the AWACS, to other Airborne command elements, to Air Traffic Control (ATC)

agencies, and to command headquarters on the ground while maintaining situational awareness of the pilot's intercept mission. During the mission, the WD's attention is continuously drawn away from the intercept because of his communications with all of these different agencies. Armed with an accurate mental model of the intercept, the WD can attend to external distractions and still maintain a level of situational awareness that will allow him to contribute accurate and timely inputs to the pilots. Without an accurate mental model, the WD will struggle with each phase of the mission and make suppositions about what is needed at any particular time. This can lead to task saturation and a reduction in the amount of coordination the WD can perform. In some cases the WD will not be able to provide all the necessary inputs to the pilots, let alone coordinate with others about the mission.

For example, On April 14, 1994, a tragic and avoidable accident occurred over the skies of Northern Iraq. Two U.S. Army helicopters were mistakenly shot down by a pair of U.S. Air Force F-15s, and twenty-six persons were killed. This was no "friendly fire" accident which happened during the "heat of battle." The USAF pilots reportedly closed to within one-half mile of the UH-60s when they identified the aircraft as Iraqi Hinds and proceeded to attack the helicopters.

Reports from the investigation into this accident indicated that a number of factors may have been the cause. In any situation, but especially during peace-time, the WD must continuously coordinate with other WDs, his supervisor, his crew commander, and several ground command agencies. Extensive coordination by the WD is necessary to clear up situations like this requiring high levels of situational awareness. The WDs must have solid mental models to increase their ability to function in a multi-tasking environment, thus increasing their situational awareness. There was a command and control breakdown because there was not enough coordination between all parties, and by default a decision was made without all the necessary information to make the correct decision.

Limited Frame of Reference. Historically, WDs train in a vacuum, receiving feedback through the apparent success or failure of the overall mission (i.e., the adversary was killed) or from other WDs' critiques. This type of feedback is inadequate and many times erroneous. WD instructors who have spent years in a training environment many times have no better mental models of the pilot's perspective than the student. This is because the appropriate mental models can only be gained through the experience of actually flying an aircraft and exposure to the pilot's environment during the mission.

Many times a successful mission from the WD's perspective is one in which the pilot did not complain about the way a WD controlled the mission. The pilot's proficiency sometimes compensates for WD errors or nullifies an outstanding WD performance, which masks the level of the contribution the WD made to the overall mission. Furthermore, most WDs never get an opportunity to fly in a fighter during a mission and observe the pilot's operations, which leaves them to generate their own mental models, right or wrong, of what was taking place in the air.

Pilots are normally based in geographically separate locations from the WDs, which makes it difficult to coordinate and brief details of the employment plan. For example, during Desert Storm, AWACS was in Riyadh, Saudi Arabia and the fighter units were scattered throughout the area. The only input the WDs had was the list of daily flights (the Air Tasking Order) which describes the fighter's call sign associated with type of aircraft and unit of assignment along with assigned target, assigned IFF, and weapons load. Virtually no communication between WD and pilot took place other than during the mission. The pilots and WDs needed to share identical mental models in order for individual missions to succeed because there was no time to debrief "one on one." WDs controlled thousands of missions each day, and each mission had different objectives and different armament. Experienced WDs relied on their years of training and debriefing with pilots in order to form the appropriate mental models.

DESCRIPTION OF AMS SYSTEM

The AMS supports initial training for WDs at Tyndall AFB, Florida. The AMS is specifically designed to help the WD students form appropriate mental models of the air environment through implementation of specific training technologies and strategies.

Design Goals

Based on the data derived during a formal training systems requirements analysis, the following objectives were identified as critical for achievement by the AMS training system.

1. WD students must be able to derive situational awareness from AWACS displays and communications.

2. WD students must be proficient in the use of all required AWACS controls.

3. WD students must be able to make judgments and decisions under stress and be able to communicate effectively in support of the mission. Effective communication skills include learning approximately 1,000 unique code words and phrases.

4. WD students must gain an understanding of the threat and friendly weapons systems and their effect

on both displays and information available to the pilot and WD.

5. WD students must gain an understanding of conceptual issues such as weather, airspace, range and azimuth resolution, intercept geometry, and tactics and their effect on the role of the WD.

Strategies for a Total Training System

In order to achieve the design goals described above, the AMS combines embedded ICW, integrated mission simulation, and live exercises on one platform. Instruction is blended with practice to facilitate and support the learning process. Practice exercises proceed from the simple one-versus-one intercept to complex live tactical intercepts. Three-dimensional graphics in the ICW help the student understand difficult concepts such as intercept and stern geometry, aircraft forces, turn radius, weather hazards, barometric pressure and altimetry, and aircraft tactics and maneuvers. Prerequisite theory and instruction required for task performance is provided at the moment it is needed via the embedded ICW.

Upon completion of each simulation or live exercise, the student can view the air situation and the mission results on the display and debrief system. The radar scope data (2D) is displayed side by side with the computer-generated visualization of the air situation (3D). This allows the WD to see what the pilot saw during the engagement and the pilot to see what the WD saw on his scope.

Hardware/Software

The AMS system includes 24 controller positions, 12 pilot stations, a digital voice communication system, an image generator-based display and debriefing system, and a host computer system. Eight consoles support three controller positions each. The consoles faithfully replicate the AWACS aircraft consoles including switch panels, keyboard, trackball, situation display, and voice communications. Each controller and pilot position is driven by a Silicon Graphics Indigo II workstation. The pilot stations allow a pilot to fly up to 10 aircraft via autopilot commands or a single aircraft hands-on through aircraft-type throttle and sidestick controllers. Each pilot station provides voice communications, a repositionable map display, heads-up display (HUD), and fire control radar display. The digital voice communications system provides multiple channels for simulated UHF radio communications and supports DIS voice PDUs. The display and debriefing system consists of a Silicon Graphics Infinite Reality image generator that produces simultaneous radar and aircraft out-the-window displays that are projected in the AMS debriefing room. The host computer is a 6 CPU Silicon Graphics Challenge XL. The host computer executes the AN/APY-2 radar and AN/APY-103 Mark XII IFF models from the Theater Air Command and Control Simulation Facility (TACCSF) located at Kirtland AFB. The AMS system supports five modes of training including ICW, stand-alone simulation, integrated simulation, combined simulation, and live exercises as described below.

External Communications

The AMS system has several connections for external communications. The system is connected to a network for participation in distributed interactive simulation (DIS) exercises. There is a modem connection for receiving air traffic data from an ARSR-4 radar, and an array of radios are connected to the system for voice communication with actual aircraft.

Training Modes

ICW. The ICW is embedded on the system to provide multimedia lessons in support of selected training objectives. The multimedia techniques include 2D and 3D computer graphics, voice-over audio, and speech recognition. During ICW training, the student uses a student console independently from the activities occurring on other parts of the AMS system. The ICW lesson content is delivered to the student at the appropriate point prior to the student performing a simulation or exercises. On any given training day, the student will complete certain ICW lessons before engaging in simulation exercises. The ICW consists of lessons which teach the WD the unique vocabulary used to communicate with the pilots, conceptual tutorials, geometry tutorials, and a dialogue game.

The vocabulary ICW starts out by teaching the student individual words and phrases and progresses to teaching the student how to integrate speaking and listening skills with other performance activities. There are many aspects of communication skills the student must learn. The student must be able to listen to messages from others to develop situational awareness and to know when information is being requested. The student must be able to provide the correct information in his own transmissions. The best way to ensure that he is understood, especially as a novice, is to learn and adhere to the accepted vocabulary and syntax. The student must be aware of the communication cadence and know when he is expected to speak and when he is expected to listen.

Because communication is an integral part of the job, the WD will practice those skills during all of the AMS simulation exercises. However, the Air Force believes that building a student's confidence in communicating can be accomplished quickly if the student is allowed to first practice in an ICW environment using speech recognition technology. Once the students gain confidence through the ICW exercises they are better prepared to perform the simulation exercises where they are controlling aircraft.

There are two types of words that help the WD and pilot to develop situational awareness ó words spoken by the pilot or others and words spoken by the WD. For words normally *heard* by the WD, the student hears a radio transmission which contains a specific word he must learn, and he selects from a choice of four alternatives the answer that most clearly describes the situation. For words normally *spoken* by the WD, the student will see a sentence on the screen in which a particular word is missing and he will say what the correct word is. The speech recognition system will judge the student's response and provide appropriate feedback. Once the student has learned individual words which form the unique vocabulary, the student proceeds with the radio transmission rehearsal activities where he looks at the radar scope display and listens to a radio transmission spoken by a pilot, air traffic controller, or senior Weapons Director. The student must understand the situation and content of the communication in order to correctly respond. The student is required to access the correct communication channel and speak directly back to the pilot, air traffic controller or senior Weapons Director. Once the student has spoken he receives feedback. At this point, he can repeat the transmission, listen to how an experienced WD would respond, replay his own transmission, and continue or quit the scenario. The student can practice each individual radio transmission as many times as he wishes.

Conceptual Tutorials. The objective of the conceptual tutorials is to enhance student understanding of concepts which are generally difficult to grasp through a lecture or printed texts. Subjects were selected for ICW which would take optimum advantage of the capability of the computer to provide audio and dynamic 2D and 3D graphic simulations to explain difficult concepts.

There are no test questions incorporated into the conceptual ICW tutorials. The student's understanding of the concepts is tested when he performs simulation exercises or takes the tests or quizzes which are a part of the classroom instruction for that material.

The following conceptual tutorials are available on the AMS.

Aircraft Forces - This lesson presents the relationship between wind, speed, angle of bank, and turn radius. The display consists of a bird's-eye-view of dynamic 3D graphic animation showing aircraft executing turns as well as 2D displays of AWACS symbology. The 3D displays will help the student understand the relationships between wind speed, ground speed, angle of bank, and turn radius. When put together with the 2D radar scope display, the student will develop an appropriate mental model in which he can relate aircraft performance to his display.

Radar Fundamentals - This lesson consists of two sections: Types of Radar and Identification Friend or Foe (IFF) Selective Feature Antenna. The Radar Fundamentals tutorial uses audio and dynamic and static 2D displays as well as dynamic 3D animation to help the student understand the concepts. Where appropriate, AWACS radar scope displays and F-15 scope displays are provided along with the animation to help the student relate three-dimensional concepts to his radar display as well as the pilot's radar display.

Barometric Pressure and Altimetry - This lesson illustrates the importance of aircraft having their altimeters set to the correct barometric pressure. The tutorial uses 2D static diagrams with dynamic 3D aircraft to explain the importance of correct altimeter settings and to show the results of failure to use the correct altimeter settings.

Communications Systems - This lesson uses static and dynamic 2D graphics to explain the capabilities and limitations of voice communication systems and frequency agile systems.

FAA Airspace - This lesson uses a 3D static display of an airspace and 3D dynamic display of aircraft, along with audio containing relevant radio transmissions to foster student understanding of the correct sequence of air traffic control procedures for military aircraft training missions. As the student hears the radio transmissions and explanations, he will be able to see the scenario of the aircraft traveling into and out of the airspace. When the scenario is completed, the student will see a menu of radio transmission events. When the student selects an event, he will see the aircraft in the airspace and hear the appropriate radio transmission. This strategy allows the student to review each procedure to enhance his understanding of the procedures as well as helping the student to learn the appropriate radio transmissions.

Geometry Tutorials and Exercises. The geometry tutorials provide the student with an understanding of the geometry used in cutoff and stern attacks. The interactive exercises provide a format in which the students apply their understanding to decision making and learn how to provide appropriate information to the pilot during cutoff and stern attacks.

There are five geometry tutorials and exercises: Intercept Geometry, Stern Overview, 180-160 Heading Crossing Angle (HCA) Sterns, 160-120 HCA Sterns, and 120-090 HCA Sterns. Each exercise presents a scenario with 2D AWACS symbology and voice-over narration. The scenario consists of a series of events in which the student is required to make decisions and provide information. The student answers a series of questions verbally. For example, in the cutoff geometry lessons, the student must identify the required fighter heading, the direction of turn, and the target's aspect.

In the stern geometry exercises, the student must identify the bearing to which he will fly the fighter; the heading associated with the HCA; whether a heading correction is required, based on the current geometry; target aspect; and correct direction of turn. During the exercises, lines will be drawn to help the student answer the questions. As the exercise continues, fewer lines will be drawn, thereby incorporating guided and unguided practice into the exercises.

Dialogue Game. The Dialogue Game will be available to the student from training days 30-60 to motivate the student to continue practicing his listening and speaking skills. The game contains all the words the student learned from the previous ICW as well as some advanced radio transmissions. Speech recognition is used to judge the student responses and provide feedback during the game. The computer will compare the scores of all the students in a class, and the student with the highest score will be the top gun "scope." That student's name will appear on the log-in menu as the "person to beat."

Stand-alone Simulation Exercises. In the stand-alone simulation mode, a student will direct the flight of up to six aircraft. Speech recognition is used to maneuver these aircraft in response to WD transmissions. Simulated aircrew transmissions are generated from prerecorded audio files. Aircraft participating in a stand-alone simulation exercise that are not directed by the student will follow canned aircraft racks. Canned aircraft tracks are prerecorded positions of aircraft that are played back under computer control. A student may pause a stand-alone simulation exercise when needed.

Integrated Simulation Exercises. Integrated simulation exercises consist of a single student directing one or more aircraft that are controlled by an operator at a single pseudo-pilot workstation. Each pseudo-pilot workstation has a flight control device, mouse, and keyboard which allow the operator to control the aircraft. Aircraft participating in an integrated simulation exercise that are not controlled by the pseudo-pilot follow canned aircraft tracks, but the pseudo-pilot can take control of these aircraft at any time.

Combined Simulation Exercises. A combined exercise consists of up to 24 students directing simulated aircraft. The radar simulation for a combined simulation exercise supports up to 960 different simulated tracks. Each simulated aircraft within a combined simulation exercise may be flown by a simulator on the DIS network, controlled at a pseudo-pilot station, or follow a canned aircraft track. Up to four F-15 full mission trainers may be used as the DIS network simulators.

Live Exercises. A live exercise consists of up to six students directing actual aircraft. Only one live exercise may be run on the AMS system at any time. Any student console which is not being used for another mode may be used to monitor the activities of a live exercise. Actual aircraft position data are provided to the AMS system from an ARSR-4 radar. The ARSR-4 radar is capable of providing position data for up to 800 tracks.

Display and Debrief System. To ensure that AWACS WD students are forming the appropriate mental models concerning the air situation and air order of battle, a display and debrief system has been developed whereby the 2D AWACS symbology and radio transmissions are correlated with a dynamic 3D out-the-window scene of the air situation from the pilot's perspective.

Upon completion of an integrated simulation exercise, a combined exercise or a live exercise, an instructor can save the data recorded from the exercise for playback on the display and debrief system (DDS). The DDS consists of two video projectors, an audio system, and an operator console. One video projector provides a 3D visualization of the air situation. Interface controls for the 3D air situation display are provided that allow for positioning of viewpoint, appearance of aircraft, display of history trails, and appearance of terrain. The other video projector is used for display of radar scope data. Interface controls are provided that allow for selection of the student console that is to be used as the source for audio and radar scope data.

Pilots and WDs sit shoulder-to-shoulder during the after-action review to discuss the mission. Pilots get to see what the WD saw ó the 2D scope display. WDs get to see what the pilot saw ó the 3D out-the-window scene of the air situation.

SUMMARY

The job of the WD is complicated. It combines procedural skills (communication, equipment operation, navigation), decision-making activities under stress (route planning, crew functions, hazard assessment, target/mission priorities), and perceptual tasks (geographic orientation, equipment controls/indicators, threat/target identification). Sensory motor skills, pattern recognition, spatial orientation and imaging abilities, selective attention, perception, and memory all play important roles. The key to successful performance as a Weapons Director lies with the individual's ability to develop and maintain situational awareness. Students need to form the appropriate mental models, develop good communication skills, grasp certain basic knowledge, and practice extensively before they will be mission-ready.

Forming Appropriate Mental Models. Students need to understand the pilot's perspective as well as warfare concepts and tactical procedures. The embedded ICW, pseudo-pilot stations, and display and debrief system support this requirement.

Developing Good Communication Skills. The vocabulary ICW and dialogue game with speech recognition will allow the students to practice communication skills during the entire course of instruction. The game will motivate students to practice as much as possible.

Obtaining Basic Knowledge. Students need to acquire certain basic knowledge, such as principles of intercept geometry, before they can be expected to perform simulation exercises. The embedded ICW will provide prerequisite theory and instruction required for task performance at the time it is needed.

Practicing. Above all else, students need to practice WD tasks on equipment that is similar to what they will use in the field. The AMS will allow the WD to participate in DIS exercises which will provide a highly realistic simulation environment. The radar feed from the ARSR-4 radar will provide a realistic operational environment critical to the maturing process of new WDs.